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# Meriones unguiculatus.

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## *Meriones unguiculatus* (Milne-Edwards, 1867)

Mongolian gerbil or clawed jird

*Gerbillus unguiculatus* Milne-Edwards, 1867:377. Type locality "Mongolie," restricted to "Eul-che-sen hao (Ershi-san hao) about 10 kilometers NE of Tschang-Kur, N Shansi, China" by Chaworth-Musters and Ellerman (1947:483) on the basis of the published itinerary of the collector (David, 1867:77).

*Meriones unguiculatus*: Thomas, 1908:106. First assignment of *unguiculatus* to *Meriones* Illiger, 1811:82.

**CONTEXT AND CONTENT.** Order Rodentia, Family Muridae (in the broad sense including the Cricetidae), Subfamily Gerbillinae. Four subspecies are recognized as follows:

*M. u. unguiculatus* (Milne-Edwards), 1867:377, see above (*chihfengensis* Mori, 1939:30, is a synonym according to Ellerman and Morrison-Scott, 1951:641).

*M. u. kurauchii* Mori, "1929–1930":417. Type locality "Cheng-chia-tun, Central Manchuria, October, 1928."

*M. u. selenginus* Heptner, 1949. Type locality vicinity of Kyakhti, in southwestern Transbaikal (from Bobrinskoy *et al.*, 1965:303, original description not seen).

*M. u. kozlovi* (Satunin, 1902:553). Type locality restricted to "Lower Kobdo River, W. Mongolia, 4100 ft." by Chaworth-Musters and Ellerman (1947:483).

**DIAGNOSIS.** Soles of feet fully haired, except for a bare patch near heel; greatest length of skull less than 40 mm.; claws dark (Chaworth-Musters and Ellerman, 1947:480; Allen, 1940:782). Most hairs are predominantly pale brown, slate gray at the base, and tipped with black; a few longer black hairs are scattered on dorsum; hairs on underside are white or tan with gray at the base. The furred tail averages 91 per cent of the head and body length, the distal half bears a crest of longer dorsal hairs, and there is a pronounced black tuft at the tip. This diagnosis is tentative and will certainly be modified when an adequate revision has been completed.

**GENERAL CHARACTERS.** Descriptions are in Chaworth-Musters and Ellerman, 1947:502; Allen, 1940:783–784; Sokolov, 1963:520; Milne-Edwards, 1868–1874:142–144; Satunin, 1902:553–554 (*Meriones kozlovi*); Mori, 1929–1930:417–418 (*M. kurauchi*); and Mori, 1939:71–72 (*M. kurauchi chihfengensis*). Males are slightly larger than females in laboratory colonies. Dental formula is i 1/1, m 3/3.

The head is short and broad, and the eyes are black and protruding. The hind limbs are slightly but not markedly elongate. Average and extreme external measurements of nineteen *M. u. unguiculatus*, including "*kozlovi*," are as follows (after Chaworth-Musters and Ellerman, 1947:502): head and body 100–125 mm. (111); tail 96–110 (102); hind foot 26–30 (27); ear 12–15 (13). The occipitonasal length of the skull is less than 36 mm. (Ellerman, 1949:108). Each upper incisor has a well-marked longitudinal groove slightly lateral to its mid-line. The molars are hypsodont, but not evergrowing (Ellerman, 1941:527); the first has three lobes, separated by two inward folds on each side; the second is bilobed; the third is small and has an almost circular crown (fig. 1). The length of the upper molar toothrow averages 4.25 (4.1–4.6) mm. (Chaworth-Musters and Ellerman, 1947:491–492).

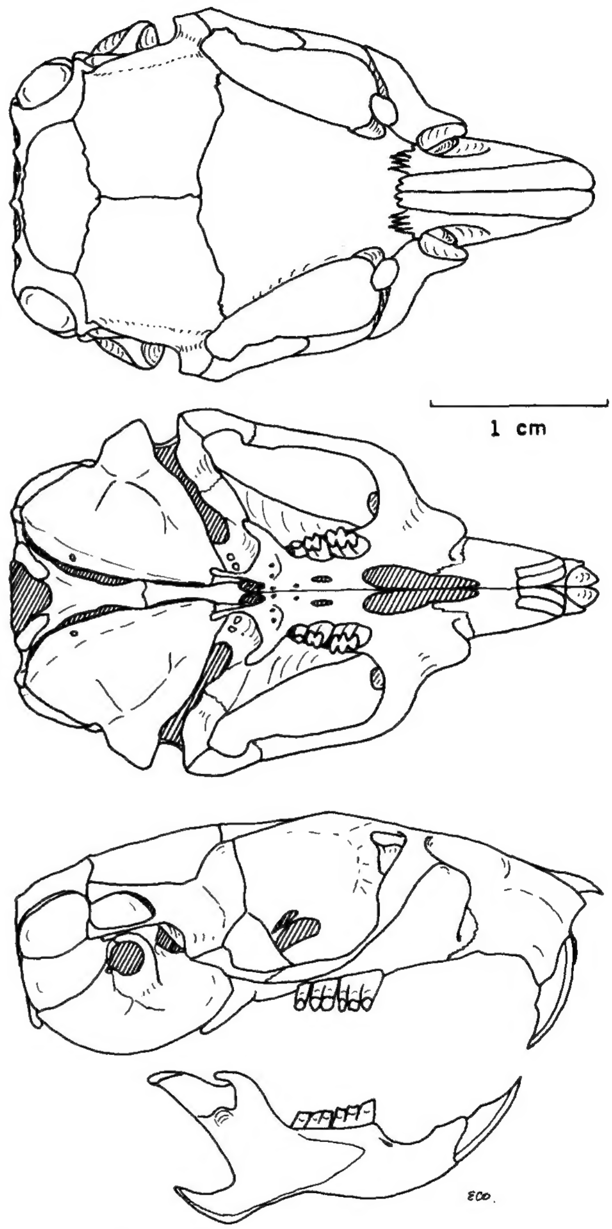


FIGURE 1. Skull of *Meriones unguiculatus*. Above, dorsal view. Middle, ventral view. Bottom, lateral view, with mandible. Drawn as a composite from skulls 194 and 195, both of females, in the collection of Dr. Emily C. Oaks, who made the drawings.

**DISTRIBUTION.** The range of the species in eastern Asia is shown in figure 2. The plotted points are the following marginal records listed clockwise beginning in northern Manchuria: Manchuli, Hailar, Kaitung, and Shangsan in Manchuria (Won, 1963:191); Chifeng in Jehol (Mori, 1939:47); Kweihwacheng, Shansi, China (Allen, 1940:785); Ordos Desert northwest of Chingpien, Shinsi, China, and Turkul Plateau in the Hami Mts., Sinkiang, China (Chaworth-Musters and Ellerman, 1947:502); west and northwest slopes of the Bogdo Ul Mts., Sinkiang, China (Dawaa, 1967:332); two localities in Tuva, two in Buryat, and two in Chita, all in U.S.S.R. (Bobrinskoy, *et al.*, 1965: map 93). Localities within Mongolia were mapped by Bannikov (1954:map 38).

According to Ellerman and Morrison-Scott (1951), the subspecies *M. u. unguiculatus* occupies all of the above-mentioned range except Manchuria. The subspecies *M. u. kurauchi* is provisionally restricted to Manchuria. According to Bobrinskoy *et al.* (1965), the subspecies *M. u. selenginus* occupies southern Transbaikal and *M. u. kozlovi* occupies the lower parts of River Kobdo, Mongolia. No fossils have been reported.

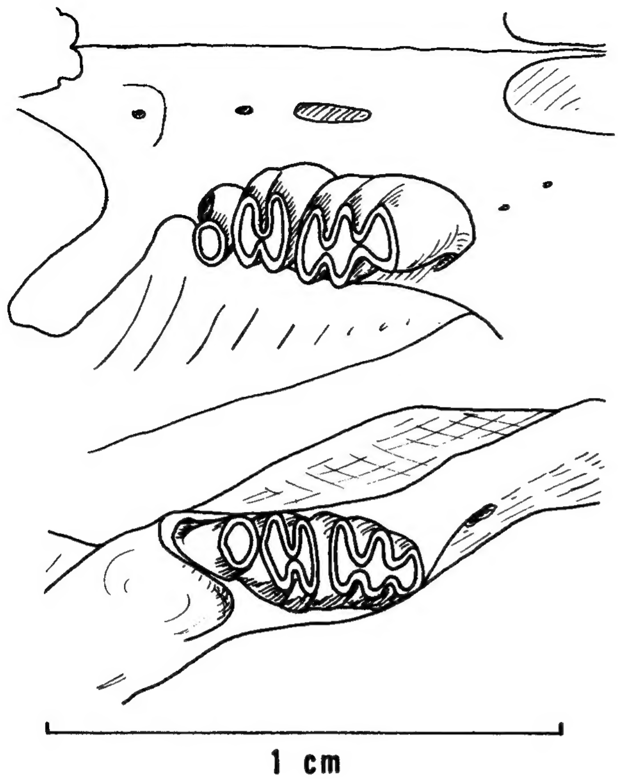


FIGURE 2. Molariform dentition (from same specimens used for figure 1). The left upper dentition is shown above and the right mandibular dentition below. Anterior is to the right in both cases.

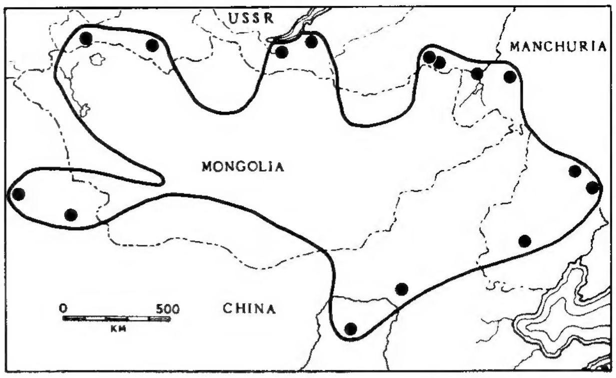


FIGURE 3. Map of Mongolia and adjacent regions showing the general geographic range of *Meriones unguiculatus*, as documented in text. Ranges of subspecies, which have never been clearly defined, are noted in text.

**FORM.** Dorsal and ventral hairs are mostly about 10 mm. long. The hairs on the tail are tan and less than 10 mm. long at the base of the tail, and longer (to 20 mm.) and tipped with black toward the tip. The ears are covered with short tan hairs anteriorly and longer whitish hairs posteriorly, and are rimmed with whitish hairs. The inner part of the pinna is nearly naked except for a few short whitish hairs near the tip. The fur around the eyes and on the cheeks is a pale tan. The whiskers are mixed black and white, ranging from 5 to 40 mm. in length. The claws are dark brown or black.

The relationships between body and organ weights in *Meriones unguiculatus* were studied by Kramer (1964) and Wilber and Gilchrist (1965). Webster (1963), Dambach (1964), and Sokolov and Skurat (1966) described a specific mid-ventral sebaceous gland in males and females. Sexual dimorphism in nuclear chromatin of cells from five different organs was described by Garner *et al.* (1969).

**FUNCTION.** Robinson (1959) measured oxygen consumption and metabolic rate, and determined the zone of thermal neutrality and heat tolerance. The Mongolian gerbil adapts to a wide range of temperature and humidity, its lower critical temperature (the lowest ambient temperature at which the animal remains in a basal or resting metabolic condition) being approximately 30°C and its zone of thermal neutrality extending to 35°C (above which it appeared to be severely affected). In environmental temperatures ranging from subzero winters to summer days of more than 38°C, it is active on the surface both day and night, and neither hibernates nor estivates. Winkleman and Getz (1962) studied water requirements and determined that when water is available the gerbil will use 0.039 grams/gram body weight/day, that it can utilize salt water of 0.8 molar concentration, and survives well without free water, stabilizing at a loss of about 14 per cent of original body weight. Water deprivation causes the mean plasma volume to decline only slightly, compared to a greater decline in rats (*Rattus*), hamsters (*Mesocricetus*) and guinea pigs (*Cavia*) under the same conditions (Kutscher, 1968). Investigations of various factors affecting blood cholesterol levels by Albers and Gordon (1962) and other authors earlier, indicate that cholesterol metabolism differs from that of other animals. Conversion of cholesterol into steroid hormones is a more important pathway of cholesterol metabolism in this gerbil than in *Rattus norvegicus* (Roscoe and Fahrenbach, 1962). Plasma proteins change with age of the animal (Ringle and Dellenbach, 1963), as do plasma glycoproteins (Dellenbach and Ringle, 1963). Normal values for hemoglobin concentration and cellular elements in the blood were determined by Ruhren (1965). The diverse spectrum of metabolism of the adrenal gland has been found to differ markedly from that of *Rattus norvegicus* (Francois, Wong, and Johnson, 1966). The adrenal gland of the gerbil is "lipid-rich" but produces only tiny amounts of corticosterone, which is one of the major secretory products of the adrenal in most other mammals (Robinson and Reiter, 1967). The mid-ventral gland may function in reproductive behavior (Feldman and Mitchell, 1968) or in territorial marking (Sokolov and Skurat, 1966; and Lindzey *et al.*, 1968). The gland becomes active at the onset of sexual maturity, castration causes involution, and administration of testosterone reverses the process (Mitchell, 1967). The gland is stimulated in both male and female gerbils by serum gonadotropin from pregnant mares, but only in the presence of gonads, and responds to progesterone and testosterone in immature females (Glenn and Gray, 1965).

**ONTOGENY AND REPRODUCTION.** Postnatal development of pelage and mid-ventral gland was studied by Feldman and Mitchell (1968). A neonate weighs about 2.5 grams, is naked and pink, and has eyes closed and ear pinnae folded and sealed. The ear pinnae unfold on days 2 to 5 (postnatal), hair develops by days 6 or 7, incisors erupt by days 10 to 16, and eyes open on days 16 to 20. The young are weaned when about 20 to 30 days of age, at which time they can eat seeds. Sexual maturity for the male is reached in 70 to 85 days and for the female in 65 to 85 days (Marston and Chang, 1965), although the testes descend between days 28 and 45 and the vagina opens between days 40 and 76 (Nakai *et al.*, 1960). The length of the estrous cycle is 4 to 6 days (Barfield and Beeman, 1968). Cells seen in vaginal smears show three phases (Marston and Chang, 1965), and may be used as a general, but not precise, indicator of stage of the cycle (the appearance of small cornified elements helps in predicting the approach of receptivity—Barfield and Beeman, 1968). Marston and Chang (1965:46) suggested the possibility of delayed implantation when more than two young are being suckled. They also presented some evidence that a pseudo-pregnancy lasting 13 to 23 days may occur. Reproduction by the female may occur as late as 20 months of age but finally ceases. Ovulation and mating may occur after the final litter is born (Marston and Chang, 1965). Mongolian gerbils are polyestrous and have a postpartum estrous period. The ovulation rate for mature virgin females within 5 days of mating averages 5.4 ova, and the postpartum ovulation rate averages 5.6 ova (Marston and Chang, 1965). Fertilization and early cleavage were studied by Marston and Chang (1964 and 1966). Spermatozoan penetration was observed 8 to 12 hours after mating and about 4 hours after ovulation. The first cleavage of the egg was completed 22 to 24 hours after penetration, the second cleavage was estimated at more than 30 hours after the first, and subsequent cleavages occurred at intervals of 20 to 24 hours. Six days after mating (or 102 hours postovulation) eggs were found in the uterus, and were mostly blastocysts of more than 30 cells. The sperm was described as having a finely tapered apex, and the

acrosome seemed to be lost during penetration. Reported gestation periods of 24 to 26 days (Nakai *et al.*, 1960) or 24 days plus 8 to 30 hours (Schwentker, 1963) may be too long. D. M. Lay (*in litt.*) has data showing 19 to 21 days of gestation. During pregnancy the female gains 10 to 30 grams. One to 12 young (usually 4 to 6) are born during the day or night, and the mother usually consumes all the placental debris and stillborn fetuses. Some data on sex ratio at birth indicate a significantly larger number of males than females (Nakai *et al.*, 1960), but this has not been found by other workers.

**ECOLOGY.** The Mongolian gerbil lives in colonies in elaborate underground burrows in dry sand or clay soil, generally on steppes and plains. Multientrance burrows vary according to landscape, extend about 45 to 60 cm. underground, and open horizontally or obliquely at the surface; tunnels are about 4 cm. in diameter. A nest and one or two storerooms are in the central part of the system. The nest is round, made of leaves of buckwheat and millet (near cultivated land) or grasses and sedges. Storerooms, empty from April to August, contain seeds of the above-mentioned plants from September to March. The seeds are used in winter as food, and in spring and summer the gerbils feed on the leaves of these plants (Tanimoto, 1943).

Gerbils were introduced into the United States of America in the early 1950's by Victor Schwentker as part of a program for the discovery and development of new animal species for laboratory use in medical research. They readily adapt to a wide range of environmental conditions without evidence of stress, require little care, and excrete only minute amounts of urine, so that cages remain dry and relatively odorless. Care and management have been described by Schwentker (1963), Marston and Chang (1965), and Nauman (1963). Three popular handbooks on gerbil care are: Robinson's *How to Raise and Train Gerbils* (1968), Monroe's *Gerbils in Color* (1967), and Socolof's *Gerbils as Pets* (1966).

The gerbil has been used in much pharmacological research. Wilber and Gardner (1963) studied effects of compazine on metabolism. Juorio *et al.* (1966), examining effects of tranquilizing drugs, found that reserpine and chlorpromazine produced an increase in concentration of homovanillic acid in the brain, and Levine and Payan (1966), studying brain damage, reported on the effects of triethyl tin, silver nitrate, Metrazol, Indoklon and cobalt. Goldenberg (1967) analyzed the response of the gerbil ileum to nicotine and acetylcholine and the blocking action of atropine, morphine, and epinephrine. Several species of gerbils, including the Mongolian gerbil, are possible carriers of bubonic plague (Tanimoto, 1942) and bilharziasis (Rockefeller Foundation Announcement, 1965). The use of gerbils in cancer research began in 1964 by Handler and Pav. Spontaneous tumors were described by Benitz and Kramer (1965). Magalini *et al.* (1965) observed a transplantable leukemia, and Quevedo *et al.* (1968) studied induction of pigmentary changes in the skin by chemical carcinogens.

The Mongolian gerbil has been used as an experimental host for the following parasites: *Leptospira* (Lewis and Grey, 1961, and Imamura *et al.*, 1962); *Trichostrongylus* (Leland, 1961 and 1963); *Echinococcus* (Norman and Kagan, 1961); *Nematospiroides* (Cross and Scott, 1960); *Haemobastonella* (Najarian, 1961); *Litomosoides* (Zein-Elden and Ashmed, 1965); *Dipetalonema* (Weinstein and Highman, 1965); *Leishmania* (Grun, 1959), *Fasciola* (Helfer, 1966); *Ascaris* (Boisvenue, 1965); and *Toxoplasma* (Shevkunova and Glushko, 1963). The species has been found susceptible to the following bacteria: *Mycobacterium leprae murim* (Nishimura and Nakao, 1955); tubercle bacilli of human and bovine strains (Imai *et al.*, 1959); and *Bordetella Bronchiseptica* (Winsser, 1960), and has been used in viral research as well (Kishida *et al.*, 1964). Mongolian gerbils show an unusually high resistance to radiation (Chang *et al.*, 1964).

**BEHAVIOR.** General observations of the Mongolian gerbil in its natural environment were recorded by Allen (1940) and Bannikov (1954) and general nesting habits were described by Tanimoto (1943). Detailed observations have been made on reproductive behavior and other behavior in the laboratory.

Mongolian gerbils are active both day and night throughout the year, and live in colonies in burrows that they dig themselves. They move on all four feet, but when not moving spend much of the time sitting up on their hind legs using their tail as a prop, described by Allen (1940:784) as sitting "spermophilelike before their burrows." The young do not do this until they are 4 to 5 weeks old.

In the laboratory, gerbils are active, curious, and gentle. Females are capable of reproducing throughout the year (Schwentker, 1967). Mating consists of short and frequent attempts at mounting separated by periods of licking or rubbing the genitals and by sporadic periods of energetic pursuit (Nauman, 1963). At first the female resists the advances of the male, but as he becomes more active she allows copulation to occur. She exhibits lordosis during copulation and permits the male to mount many times (Marston and Chang, 1965). A series of intromissions culminates in ejaculation, which is followed by a period of grooming and sexual refractoriness (Barfield and Beeman, 1968). The gerbil is capable of ejaculating a number of times in a single mating session, and the number of intromissions preceding each ejaculation is three to four times greater than for other multi-ejaculating rodents (Kuehn and Zucker, 1968). This is probably related to the amount of stimulation needed by the female for successful pregnancy. Between mating attempts males and less frequently females display a "foot-stomping" or "thumping" behavior, consisting of staccato pounding of the rear feet against the ground in brief repetitive bursts, lasting for 2 to 30 seconds (Kuehn and Zucker, 1968). Squealing noises are frequently produced by sexually excited gerbils and females with young.

Auditory sensitivity to low frequency sounds is high; response occurs within the range of 200 to 32,000 hz. and is best to sounds of 3000 to 5000 hz. (Finck and Sofouglu, 1966). Optimum sensitivity is at a much lower frequency than in *Mus* (10,000 to 12,000 hz.) or *Rattus* (40,000 hz.), but is near that of desert-dwelling *Dipodomys* (2000 to 4000 hz.).

Gerbils quickly learn an "avoidance response"—that is, to respond to noise timed to precede an experimental electrical shock by pressing a lever that prevents the shock (Walters *et al.*, 1963), and have a markedly higher avoidance response than another desert species, the kangaroo rat, *Dipodomys ordii*, although not so high a response as that of *Mus musculus* (Boice *et al.*, 1968). They learn quickly as measured in both two- and four-choice discrimination tests (King *et al.*, 1968). In a relatively large enclosure, Mongolian gerbils entered the central open area more often, remained there longer, and moved about more than did albino rats (Nauman, 1968).

Gerbils tolerate high densities in captivity. Cage mates, regardless of sex, groom each other extensively, wrestle, and sleep in contact with each other. The position when sleeping varies with the temperature; at or above 30°C an animal may sleep on its back with its legs in the air, at about 25°C it tends to lie on its side, and at less than 25°C it sleeps in a sitting position with head tucked down between the rear legs (Nauman, 1963). Individuals may groom each other simultaneously, but usually one lies motionless while another grooms him. The gerbil is non-aggressive in that wrestling behavior usually turns into grooming. However, when a new animal is placed in the home cage of another, serious fights may occur, sometimes ending in the death of one (Nauman, 1963).

Unusual spontaneous seizures occurred in about one of every five gerbils during behavioral testing by Thiessen *et al.* (1968). The cause is not yet known.

**GENETICS.** The diploid chromosome number for *M. unguiculatus* is 44, with a karyotype containing 22 metacentric, 10 submetacentric, and 10 acrocentric autosomes, a large submetacentric X and a smaller submetacentric Y chromosome; the fundamental number of chromosomal arms is 78 (Nadler and Lay, 1967:288, fig. 2). Schwentker (1964) reported that sterility and ovarian tumors occurred in some inbred lines after nine or 10 generations.

**REMARKS.** The use as pets of species such as the Mongolian gerbil, which probably could adapt to some areas in North America if released, carries a grave risk of damage to the environment and to human agriculture and health.

*Pallasiomys* Heptner, 1933:150, type species *Gerbillus erythroura* Gray, 1842, included *unguiculatus*. *Pallasiomys* was subsequently treated as a subgenus (see Chaworth-Musters and Ellerman, 1947:479) or less (Nadler and Lay, 1967:290).

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